SYNOPSIS OF RESEARCH PROJECT

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4.	**Name of the Degree Submitted for**	**:**	Ph.D.
5.	**Major Subject**	**:**	Seed Science and Technology
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7.	**Name of Major Guide**	**:**	Dr. J. B. Patel, Professor and Head, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh.
8.	**Title of Research Project**	**:**	**RESPONSE OF SOYBEAN [G*lycine max* (L.) Merrill] TO ORGANIC SEED COATING AND FOLIAR SPRAY WITH RESPECT TO SEED YIELD ATTRIBUTES AND SEED STORABILITY UNDER DIFFERENT STORAGE CONDITIONS**

9. Introduction

Soybean (*Glycine max* L.) is one of the important sources of vegetable oil and plant protein. It is a member of family *Leguminosae*, sub family *Papilionoidea*, 2n = 40, is supposed to have originated in China. It contains 43.2 per cent protein and 19.5 per cent oil (Chowdhury *et al.,* 2015). It is the third important oilseed crop next to groundnut and mustard (Rai *et al*., 2016). Soybean is known as "Golden Bean" and is commonly referred as 'miracle crop' or 'gold from soil'.

Seed is the fundamental and most important input in agriculture, and its quality has a significant impact on the establishment, growth, and ultimate output of the crop. Due to their high oil content, soybean seeds are susceptible to mechanical harm, moisture changes and oxidative deterioration, which lowers their germination potential, seedling vigor, and storability. Jeffs (1986) examined a number of coating methods for increasing agricultural output during the mid-20th century. In the last two decades, seed-coating technology has advanced quickly, offering a cost-effective method for improving seeds,

particularly for agronomic and horticultural plants with larger seeds (TeKrony, 2006). The seed coating technique involves applying a variety of materials, including fertilizers, nutrients, moisture-attracting or repellent agents, plant growth regulators, chemicals, organic formulations and insecticides, to seed using adhesive agents in order to improve seed germination and performance (Freeborn *et al.,* 2001). By coating soybean seeds with novel seed-coating agent, Zeng and Zhang (2010) were able to increase production by 17.95% at a lower cost (25.75%) than a commercially available product. According to Zeng *et al.* (2012), chitosan coating is effective for controlling pests and boosting soybean production. According to Mandal *et al.* (2000), finely powdered dry red (hot) chilli (*Capsicum frutescens* L.) fruit (1 g powder per kg of seed) and catharanthus (*Catharanthus roseus* L.) leaf powder (2 g per kg of seed) improved germinability over the untreated control in soybean. Seed coating offers the benefit of positioning the seed enhancement material exactly on the seed without blocking the seed shape. As a far safer approach, seed coatings consisting of natural or synthetic polymers have been quickly embraced by the seed business.

Cow products like dung, urine, milk, curd and ghee are used to create the less expensive, environmentally friendly, organic products *jeevamruth* and *panchagavya*. The *panchagavya* is a potent plant growth stimulant that improves the biological effectiveness of plants. It is used to enhance the nutritional content of fruits and vegetables, stimulate soil and shield plants against illnesses (Boraiah *et al.,* 2017). From the Vedic era, *jeevamruth* and *panchgavya* have been the most widely utilized and well-known organic supplements in the area of organic farming. These liquid bio-stimulants were an improvement over ancient science; they contain a wealth of vital macro and micronutrients, healthy microbes, enzyme, and growth regulators necessary for plants' healthy development. They also function as a tonic for the plants, increasing crop production (Rijal *et al.,* 2021). Cow urine is a great source of plant nutrients and has anti-fungal qualities. It has been utilized in crop production for centuries (Boraiah *et al.,* 2017).

Soybean seeds are at their physiological maturity stage, when they are at their most vigorous and have the highest germination potential; however, this value decreases with time (Carvalho *et al.,* 2017). The soybean is one of the plants whose seeds are said to be the most susceptible to degradation (Shelar *et al.,* 2008). Reactive oxygen species generation increases and mitochondrial activity decreases as seeds age, resulting in deterioration (Xin *et al.,* 2014). With increasing age, lipid peroxidation and electrical

conductivity rise, but germination, vigour, total sugar content, soluble proteins and enzymatic activity decrease (Chandel *et al.,* 2015), leading to a decline in quality with a reduction in seed vigour and germination. Due to the high amount of polyunsaturated fatty acids in soybean seeds, they are susceptible to non-enzymatic peroxidation (self-peroxidation) and enzymatic peroxidation (lipoxygenase), both of which contribute to a rapid decrease in seed quality (Singh *et al.,* 2017). As a result, soybean seeds are usually thought of as having a short shelf life.

One of the most important input variables affecting yield and production is the quality of soybean seeds. The shelf life of soybean seeds is likewise limited when stored at ambient tropical temperatures and germination rates drop quickly. However, the shelf life of seeds can be increased by using the correct packaging materials (Kamara *et al.,* 20214) or by storing them at -20°C (Tetteh *et al.,* 2023). To preserve seed quality, Cyril *et al.* (2019) suggest good post-harvest management practices, such as prompt harvesting, drying seeds to 12–13% moisture content and utilizing superior storage methods like hermetic storage.

Understanding the interaction between organic bioprimers and soybean seed physiology is crucial for developing environmentally safe and economically viable seed enhancement strategies. Therefore, the present study aims to evaluate the effectiveness of organic seed-coating and organic foliar spray in improving soybean seed quality, growth performance, yield attributes and seed storability, contributing to sustainable soybean production and quality seed supply.

10. Practical Utility of the Research Project

Soybean (*Glycine max* L.) seeds are highly susceptible to rapid deterioration during storage due to their high oil content, thin seed coat and hygroscopic nature. Under tropical and sub-tropical conditions such as those prevailing in Gujarat, high temperature and fluctuating relative humidity accelerate seed ageing, resulting in loss of viability, reduced germination, poor seedling vigor, and increased susceptibility to storage fungi and insect infestation. Inadequate storage facilities and prolonged storage under ambient conditions further aggravate the problem, leading to the use of poor-quality seeds by farmers.

During cultivation, soybean faces several constraints including uneven germination, poor field emergence, seedling mortality, moisture stress during early growth stages and vulnerability to soil and seed-borne pathogens. In rainfed areas of Gujarat, erratic rainfall and intermittent dry spells often result in weak crop

establishment, which ultimately affects plant growth, yield attributes, and final productivity. Additionally, excessive dependence on chemical seed treatments may adversely affect soil health and beneficial microbial populations.

Assessment of the impact of organic bio-primers on growth and yield parameters will aid farmers and seed producers in adopting sustainable practices that enhance crop performance and productivity without relying heavily on chemical inputs. Improved growth and yield attributes resulting from organic seed coating can contribute to higher economic returns and environmentally safe soybean cultivation.

The evaluation of organic foliar sprays provides a scientific basis for identifying sustainable nutrient supplementation strategies capable of enhancing crop productivity. By quantifying their influence on yield attributes such as number of pods, seed weight, biomass accumulation, and harvest index, the study generates evidence for the effectiveness of organic inputs in improving physiological efficiency and assimilates partitioning

Determining optimal storage conditions and evaluating organic seed-coating formulations provide practical strategies for maintaining post-harvest seed quality. By assessing the effects of temperature, humidity, containers, and coatings on seed viability, vigor, and deterioration, the study develops validated protocols that reduce losses during storage. Improved storability ensures the long-term availability of high-quality seeds, enhances seed supply chain efficiency, and benefits farmers, seed producers, and storage agencies through better shelf life and economic returns

Overall, this research will support the development of cost-effective, organic, and sustainable seed-coating technologies that can be practically adopted at both farmer and commercial seed production levels. The integration of seed coating with appropriate storage methods offers an effective strategy for minimizing post-harvest losses and ensuring the availability of high-quality planting material.

11. Objectives

1. To evaluate the effect of organic seed coating on seed yield and its attributes
2. To evaluate the effect of organic foliar spray on seed yield and its attributes
3. To find out the best seed storage condition
4. To assess the efficacy of the organic seed-coating formulations on improving seed storability

12. Review of Literature

The review of literature pertaining to the objectives of the present study in soybean is very scarce. Therefore, such review of other crops is reviewed and presented herewith.

12.1. To evaluate the effect of organic seed coating on seed yield and its attributes

Loknadhan *et al.* (2012) reviewed the wide agricultural potential of neem (*Azadirachta indica*) and its derivatives in crop production. The authors highlighted neem's multifunctional role as an insecticide, antifeedant, antifungal, antiviral and nematicidal agent, attributing these effects to bioactive compounds present in neem seeds, leaves, bark and flowers. The study emphasized the use of neem products in seed treatment, soil amendment, nutrient management and pest control. Neem-based formulations such as neem cake, neem oil, neem compost and neem-coated fertilizers were reported to enhance nutrient use efficiency, suppress pests and improve crop sustainability. Overall, the review concluded that neem-products offer an eco-friendly, cost-effective alternative to chemical inputs, promoting sustainable agriculture and long-term soil and crop health.

Thirusendura Selvi *et al.* (2019) evaluated the effectiveness of seed quality enhancement techniques through seed pelleting to improve seedling vigour and field establishment of bitter gourd (*Momordica charantia* L.), an important medicinal vegetable crop. The study focused on the use of botanicals such as arappu, pungam, neem, notchi, moringa, prosopis and rhizome powders of turmeric and vasambu as pelleting materials at different rates (150, 200 and 250 g/kg seed). A 10% maida solution was used as an adhesive to ensure uniform coating of seeds. The results clearly indicated that seed pelleting with arappu at 200 g/kg seed was superior to other treatments, resulting in improved germination (73%), enhanced seedling vigour, uniform seedling emergence and higher survival percentage. Pungam ranked next in effectiveness among the botanicals tested. The study highlights seed pelleting with botanical powders as an effective seed enhancement strategy to overcome poor field emergence and improve seedling establishment in bitter gourd.

Zhang *et al.* (2022) comprehensively reviewed the role of biochar as a sustainable and economical material for seed coating and its effects on seed germination, plant performance and soil health. The paper discusses the development of seed coating technology and highlights biochar as an effective coating agent due to its high porosity, adsorption capacity and nutrient-holding ability. The authors reported that biochar-based

seed coatings improve seed germination, seedling vigor, early plant establishment and nutrient uptake, while also enhancing soil physical, chemical and biological properties. Biochar coatings were shown to promote beneficial microbial activity, improve moisture retention and reduce nutrient losses, thereby contributing to better crop growth and productivity. The review further emphasized the eco-friendly nature of biochar, as it utilizes agricultural waste and supports carbon sequestration. Although the article mainly synthesizes findings across multiple crops rather than focusing exclusively on soybean, its conclusions strongly support the potential of biochar-based organic seed coatings to enhance crop performance, sustainability and long-term soil health, making it highly relevant for research on organic seed coating and yield improvement in soybean.

Using premium seeds guarantees successful crop establishment, healthy growth, and enhanced production in terms of both quantity and quality. Biochar-based seed coating has recently been recognized as a novel, efficient and environmentally responsible strategy for improving seed quality, seedling consistency and nutrient availability. Zhang *et al.* (2023) conducted laboratory experiment on two water-saving and drought-resistance rice (WDR) varieties (Huhan1512 and Hanyou73) utilizing biochar formulations with varying contents (20%–60%) in order to investigate the effects of biochar coating on the surface mechanical properties of coated seeds, rice emergence and growth, and related physical and physiological metabolic events. The best biochar coating percentage was 30% (BC30), as the ideal concentration of biochar was discovered to have a substantial effect on the emergence features and seedling performance of the two rice varieties when compared to the uncoated treatment. BC30 improved the average emergence rate (9.5%), emergence index (42.9%), shoot length (19.5%), root length (23.7%), shoot dry weight (25.1%), and root dry weight (49.8%) across both the varieties. Biochar coating-induced improved germination features and robust seedling development were highly correlated with increased water absorption by seeds, increased respiration rate and α-amylase activity and increased build-up of soluble sugar and soluble protein. Additionally, the evaluation of mechanical characteristics associated with the quality of seed coating revealed that increasing the proportion of biochar in the coating mix reduced the coated seeds' integrity and compressive strength, as well as the time it took for the coating to break down. Biochar coating is a cost-effective way to improve the quality of crop seeds and the establishment of seedlings, as shown by the data.

Vaghasiya *et al.* (2024) estimated the effect of pre-sowing seed treatments on seed yield and quality of soybean. The experimental comprising two factors, kinds (GJS 3 and JS 335) and pre-sowing seed treatment s(control, hydration- dehydration treatment with distilled water for 8 hrs, $CaCl_2$ for 8 hrs. (15 ml/l), KH_2PO_4 for 8 hrs. (20 ml/l), KNO_3 for 8 hrs. (10 ml/l), PEG 6000 for 8 hrs. (100 ml/l), *Rhizobium japonicum* culture for 8 hrs. (100 ml/ l), seed coating with sweet flag rhizome powder (5 g/kg seed), seed coating with cytozyme SDM powder (3 g/ kg seed) and seed coating with neem kernel powder (5 g/ kg seed). The observations were recorded on seed yield per plant and its contributing traits in the field. Variety JS 335 showed it superiority over GJS 3 recorded the highest field emergence, seed yield and its attributes with lower days to 50 per cent flowering and days to maturity. Among pre-sowing seed treatments, seed coating with sweet flag rhizome powder (5g/ kg seed) recorded the maximum field emergence, seed yield and its attributes.

12.2. To evaluate the effect of organic foliar spray on seed yield and its attributes

Deotale *et al*. (2017) reported that foliar application of cow urine significantly influenced the chemical, biochemical and yield parameters of pigeonpea (*Cajanus cajan* L.). Two foliar sprays of cow urine at different concentrations (4, 6 and 8%) and NAA (25 and 50 ppm), applied at 45, 65, 85 and 105 days after sowing, were evaluated. Among the treatments, foliar spray of 6% cow urine recorded higher chlorophyll content, protein percentage and improved biochemical attributes compared to the control. The treatment also resulted in superior yield parameters such as number of pods per plant, test weight and seed yield per plant. Further, the combined application of cow urine (6%) with NAA (50 ppm) showed the maximum improvement in chlorophyll content, protein content, seed weight and seed yield, indicating a synergistic effect of organic bio-stimulants and plant growth regulators. The study concluded that foliar spraying of cow urine alone or in combination with NAA effectively enhanced chemical, biochemical and yield-contributing parameters of pigeonpea.

Sutar *et al*. (2019) investigated the impact of foliar treatment of organic liquid formulations on soybean (*Glycine max* L.) growth, yield and quality under inceptisol. The experiment tested the effectiveness of vermiwash, compost tea and *panchagavya* administered as foliar sprays at various concentrations, as well as the advised dosage of fertilizers. The findings demonstrated that spraying of vermiwash, compost tea and *panchagavya* on soybean foliage greatly improved both the quantity and quality of the crop. Treatment, which consisted of 3% foliar spray of RDF + *panchagavya* followed by

treatment, which consisted of 75% foliar spray of RDF + compost tea, were the best produced the good yield and quality.

Chaudhary *et al.* (2022) performed a field trial to investigate the impact of various organic inputs on the development, output and economics of soybean under rainfed circumstances. The treatments included soil application of *jeevamrut* at 500 L/ha, along with foliar nutrition sources such as control, 4% *panchagavya*, 2% new organic liquid, 4% seaweed extract, 4% cow urine and 2% vermiwash, applied at 30 and 45 days after planting. The results showed that the application of organic inputs significantly improved growth characteristics like plant height, number of branches per plant and root nodulation when compared to the control. Foliar application of organic compositions also resulted in a notable improvement in yield characteristics such as the number of pods per plant, seed yield and stover yield. Cow urine and *panchagavya*, two of the treatments, significantly enhanced growth and output, demonstrating the efficacy of liquid organic manures in boosting the productivity and economic returns of soybeans grown in rainfed environments.

Sharma *et al.* (2024) examined the impact of foliar application timing of various bio-stimulants on the development, quality and nutrient absorption of chickpea in the mid hills of Himachal Pradesh. The field trial involves applying three times foliar application in the main plot, consisting of pre-flowering, pod initiation and pre-flowering + pod initiation, as well as bio-stimulants in the sub-plot, such as vermiwash @ 10%, cow urine @ 10%, *jeevamrit* @ 10% solution and *panchagavya* @ 3% solution. The findings revealed that the foliar application of *panchagavya* @ 3% solution at pre-flowering + pod initiation stage resulted in significantly higher qualitative characteristics (protein yield), nutrient absorption (N, P & K), and crop growth parameters (plant height, number of branches per plant, dry matter accumulation, number of nodules per plant, dry weight of nodules).

Swathi *et al.* (2025) assessed the impact of foliar treatment with liquid organic manures on soybean (Glycine max L.) productivity, profitability and nutrient absorption under organic and natural farming systems. The trial included three agricultural techniques in vertical strips: organic farming, natural farming and intensification of natural farming. The five liquid organic manures used were vermiwash (5%), *jeevamrutha* (20%), *panchagavya* (5%), cow urine (10%) and water spray. The field had gone through the three-year transition period necessary to switch to chemical free farming. The outcomes demonstrated that organic farming had a higher seed yield,

halum yield, gross return and nutrient absorption of macro (NPK) and micro nutrients (Fe, Mn, Zn, and Cu) than natural farming techniques when analyzed collectively. With natural farming, however, the harvest index, net return and B:C ratio were all greater than with organic farming and the intensification of natural farming. *Panchagavya* outperformed other liquid organic manures in terms of yield, gross return, total nitrogen uptake and micronutrient uptake. However, when compared to both organic farming and the intensification of natural farming, natural farming produced better results in terms of net returns (Rs. 108931), harvest index (42.88%), and B:C ratio (3.96). Organic farming was compared to the recommended package of practices in terms of gross returns, seed yield and halum yield. Nevertheless, the optimum treatment of natural farming had a 16% lower net return and a lower B:C ratio (0.39) than the recommended package of practices.

12.3. To find out the best seed storage condition

Kandil *et al.* (2013) examined how the quality of soybean seeds was impacted by storage time, storage circumstances and packing materials in Egypt. Using various packing materials for seeds and pods, such as cloth and plastic bags, the research examined five soybean cultivars (Giza 21, Giza 22, Giza 35, Giza 111, and Crawford) under refrigerator (10°C ± 1) and ambient temperature for storage periods of 3, 6, 9 and 12 months. The findings showed that ambient storage produced higher acid and peroxide counts, while refrigeration storage maintained higher oil and moisture content. The investigation also revealed notable interactions between cultivars, storage lengths, conditions and packing, with certain cultivar (such as Giza 111) demonstrating superior storability under refrigerated circumstances.

Baributsa and Baoua (2022) examined the effectiveness of hermetic storage in preserving of soybean seed quality over a three-month period under high relative humidity circumstances. The treatments included Purdue Improved Crop Storage (PICS) and control polypropylene (PP) woven bags maintained at 30 and 80 per cent relative humidity. Each month, the moisture content and germination rate were determined. With the exception of seed kept in PP bag at 80 per cent relative humidity, where the moisture level more than doubled after a month, there were no changes in moisture content. For soybean seeds held in PICS bags for three months at 30 and 80 per cent relative humidity, the germination rates did not vary. When soybean seed was kept in a PP bag at 30 per cent relative humidity, its germination rate was comparable to that of seed kept in PICS bag at 30 per cent and 80 per cent relative humidity, with the exception that, after

the third month, it was significantly lower than that of seed kept in a PICS bag at 30 per cent. Compared to soybean seeds kept in PP bags at 30 per cent and in PICS bags at 30 per cent and 80 per cent, germination rates fell by around 3, 6 and 7 per cent, respectively. But after three months, the germination rates of soybean seed stored in PP bags at 80 per cent relative humidity decreased by 98%. The Pearson correlation between seed germination and moisture content was a remarkable negative (80.6%). Soybean seed may be safely stored in commercially available hermetic bags by seed producers, farmers, and traders in the humid tropics.

Koskosidis *et al.* (2022) examined the impact of storage conditions on the quality of soybean seeds. The genetic material was composed of ten soybean cultivars, the seeds of which were kept in refrigerators and at room temperature before being tested for germination, electrical conductivity and free fatty acid content. To assess the long-term impact of storage on seed quality, every genotype underwent accelerated aging at 40°C for up to 48 days, and the Ki value was calculated using the viability equation. The general conclusion was that storage environment had a significant impact on seed quality and that storing under cooling conditions had a positive impact, which was reflected in higher germination rate, lower electrical conductivity and free fatty acid percentage and increased storage life. Additionally, findings clearly demonstrated the superior quality of the Adonai, Celina and Neoplanta cultivars, particularly when stored in cool environments, as they had a higher germination rate and greater storage potential.

According to Tetteh *et al.* (2024), soybean loses its quality quite quickly when kept at room temperature. As a result, a 14-month experiment was conducted to determine how storage conditions affect the lifespan of soybean accessions and to see if there were any differences between them. The seeds of five soybean accessions were collected, processed and kept at room temperature (28°C) and in a deep freezer at -20°C for eight months. Two months after storage, the seed vigour and germination rate were used to evaluate the quality of the stored seeds. The 100 seed weight and original seed quality were determined prior to storage. At 4, 6 and 8 months following storage, the results revealed considerable variations in seed vigour and germination rate across the five soybean accessions. The quality of soybean seeds kept at room temperature decreased considerably at 8 months after storage, whereas the seeds kept at low temperature retained their quality in terms of seed vigour and germination rate.

Vaghasiya *et al.* (2025) examined the impact of pre-storage seed treatments on the storage eventuality in soybean seed. The seeds of two soybean types (GJS 3 and JS

335), with a moisture content of 7 per cent, were treated with various pre-storage dry dressing seed treatments (S_1 - Control (undressed seed), S_2 - Boric acid powder @ 5 g/ kg seed, S_3 -Neem kernel powder @ 5 g/ kg seed, S_4 : Wood ash @ 5 g/ kg seed and S_5 - Calcium hypochlorite @ 5 g/ kg seed) before being packed in three containers: an aluminum foil bag, a non-woven fabric bag and an airtight plastic container. The seeds were assessed for seed quality characteristics, including seed moisture content (%), germination (%), seedling length (cm), seedling dry weight (mg), seedling vigour indicator - I and seedling vigour indicator - II, up to eight months after storage, with a two-month interval between each evaluation. The average seed moisture content rose to 3–4 per cent over the course of eight months of storage, with the highest value being recorded in non-wooven fabric bags (11.76%) and the lowest value in air-tight plastic containers (10.67%), which were comparable to seeds stored in aluminum foil bags. The seeds kept in airtight plastic containers showed a notable increase in the maximum germination (83.43%), seedling length (9.29 cm), seedling dry weight (10.77 mg), seedling vigor index I (777.78) and seedling vigor index II (902.04) after eight months of storage.

12.4. To assess the efficacy of the organic seed-coating formulations on improving seed storability

Nazareth *et al.* (2018) assessed the effectiveness of neem and tulsi leaf powders on the seed mycoflora and seed quality of oilseeds, such as mustard, niger, groundnut and sunflower. Regular blotter, agar plate and paper towel techniques were used to analyze seed-borne fungi. Seed treatments with herbal powders were administered singly and in combination (1:1) at concentrations of 2, 5 and 10%. The data showed that neem and tulsi powders significantly decreased the prevalence of seed-borne fungi when compared to untreated controls. Herbal powder treatments also enhanced seed germination, seedling emergence, shoot length and root length. The study came to the conclusion that neem and tulsi leaf powders may be used as environmentally friendly seed treatments to control seed-borne pathogens and increase the vitality of oilseed seeds.

Gill and Singh (2012) studied the efficiency of certain plant powders against pulse beetles on chickpea. The impact of various plant powders, such as neem leaf powders, *dharek*, *sadabahar* and turmeric rhizome powder at 2.0, 3.0 and 4.0 per cent, on the germination of chickpea seeds was tested against pulse beetles (*Callosobruchus chinensis*). When recorded at monthly intervals for up to four months of storage, the per

cent weight loss, population growth and per cent grain damage in chickpea grains treated with turmeric rhizome powder at 2.0, 3.0 and 4.0 per cent were found to be considerably lower than the other treatments and the untreated control. Nevertheless, even after four months of storage, none of the plant powders at any concentration had any negative impact on the germination of chickpea seedlings.

Oyekale et al. (2012) examined the impact of various botanicals on sesame seed quality. They found that sesame seeds that treated with neem leaf powder or dry pepper powder maintained a seed germination rate of over 80% for up to 18 weeks. Neem leaf powder seed treatment was specifically advised for sesame seed pre-treatment storage because it preserved seed viability and seedling vigour at the highest level when compared to the other eight treatments. It was also suggested that more botanicals (different plant source and different parts of the plant - leaves, extracts, etc.) might still be experimented for sesame seed storage and with different varieties of the crop.

Hridya *et al.* (2017) seen that with the increase in storage time, seed treated with fenugreek seed powder in soybean showed a higher germination rate of 88%, which was compared to other treatments, and it was on a decreasing trend, indicating a decrease from 88% to 73%. As the storage duration increases, the average root length of the seedling gradually falls from 13.1 cm to 8.0 cm. The root length of fenugreek seed powder (13.1 cm) was the greatest, but the root length of untreated seeds was the least (8.0 cm) at the conclusion of storage.

Verghese *et al.* (2018) reported that, there was no discernible change in the rate of germination between treatments of fresh seeds, but aged seeds exhibited a noticeable variation in the rate of germination between the control and other treatments, with all treatments (fenugreek seed powder, custard apple leaf powder, and moringa leaf powder) being on par. On the other hand, fenugreek seed powder produced a higher dry matter output (0.273 g/10 seedlings) among the eight botanicals tested, which was on par with custard apple leaf powder (0.268 g/10 seedlings).

Kumar *et al.* (2023) examined the impact of organic seed treatments (*Trachyspermum ammi, Azadirachta indica, Dalbergia sissoo, Murraya koenigii, Ocimum tenuiflorum, Ocimum canum, Curcuma longa* rhizome and leaf powder, woodash, and *Ocimum basillicum* leaf powder) and storage time on the seed quality of mungbean cv. MH 318 and MH 421. For eighteen months, the new seeds were kept in polythene bags at room temperature after being treated with the aforementioned botanical powders. Six, twelve and eighteen months following treatments during storage,

the seed quality factors were measured. The six-month-old seeds of both types performed better in terms of seed quality characteristics, such as germination, speed of germination, vigour index, emergence inde, and seedling establishment, compared to newly treated seeds, according to the findings. As the storage period was extended, there was a consistent deterioration in the quality parameters after six months of storage. The turmeric rhizome powder used to coat the seeds improved and maintained their quality throughout an 18-month storage period.

Vaghasiya *et al*. (2025) investigated the impact of pre-storage seed treatments on the storage eventuality in soybean seed. After being packed in three containers - an aluminum foil bag, a non-woven cloth bag and an airtight plastic container, the seeds of two soybean kinds (GJS 3 and JS 335) with 7 per cent moisture content that had been treated with various pre-storage dry dressing seed treatments (S_1 - Control (undressed seed), S_2 - Boric acid powder @ 5 g/ kg seed, S_3 -Neem kernel powder @ 5 g/ kg seed, S_4: Wood ash @ 5 g/ kg seed, and S_5 - Calcium hypochlorite @ 5 g/ kg seed) were stored. Seed quality parameters such as seed moisture content (%), germination (%), seedling length (cm), seedling dry weight (mg), seedling vigour index - I, and seedling vigour index - II were assessed for the seeds at two-month intervals for up to eight months after storage. The highest seed moisture content (11.25%) was found in the control after eight months of storage, while the lowest seed moisture content (10.89%) was found in seeds treated with wood ash at 5 g/kg, which remained at par with seeds treated with neem kernel powder at 5 g/kg and calcium hypochlorite at 5 g/kg, which had seed moisture contents of 11.02% and 11.05%, respectively. The highest germination (80.11%), seedling length (9.17 cm), seedling dry weight (11.29 mg), seedling vigour index I (740.01), and seedling vigour index II (917.52) were observed in seeds treated with wood ash at 5 g/kg seed, followed by neem kernel powder at 5 g/kg seed, with germination (78.61%), seedling length (8.77 cm), seedling dry weight (10.46 mg), seedling vigour index I (694.03) and seedling vigour index II (832.64) after an eight-month storage period.

13. Materials and Methods

13.1 Experiment I: Effect of organic seed coating and foliar spray on yield and yield attributes in soybean (*Glycine max* L.)

13.1.1 Locations **:** Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh

13.1.2 Year and season of experiment : *Kharif* 2026 and 2027

13.1.3 Crop and Variety Soybean, GS 4

13.1.4 Experimental design : Randomized Block Design (Factorial)

13.1.5 Number of replications : 3 (Three)

13.1.6 Spacing : 45 cm x 5-10 cm

13.1.7 Plot size : 4 m x 0.9 m

13.1.8 Treatment details

Factor I: Foliar spray (F)

F_1: Cow urine 5% at 30 and 45 DAS

F_2: *Panchagavya* 5% at 30 and 45 DAS

F_3: *Jeevamrut* 2.5% at 30 and 45 DAS

Factor II: Seed coating (S)

S_0: Control

S_1: Gum coated seed 0.5 g

S_2: Tea leaf powder 10 g

S_3: Turmeric rhizome powder 10 g

S_4: Garlic bulb powder 10 g

S_5: Groundnut shell (biochar) 10 g

S_6: Neem leaf powder 10 g

S_7: Curry leaf powder 10 g

S_8: Lemon leaf powder 10 g

S_9: Arappu leaf powder 10 g

S_{10}: Tulsi leaf powder 10 g

S_{11}: Fenugreek seed powder 10 g

Total treatment combinations: 36

13.2 Experiment II: Effect of organic seed coating formulations on germination and quality parameters in soybean (*Glycine max* L.) under different storage conditions

13.2.1 Locations : Department of Seed Science and Technology, Collge of Agriculture, Junagadh Agricultural University, Junagadh

13.2.2 Year and season of experiment : *Kharif* 2026 and onwards

13.2.3 Crop and Variety Soybean, GS 4

13.2.4 Experimental design : Completely Randomized Design (Factorial)

13.2.5 Number of repetitions : 4 (Four)

13.2.6 Treatment details : **Factor I: Storage conditions (C)**

C_1: Cold storage 10℃ ± 1℃

C_2: Hermetic storage

C_3: Ambient storage

Factor II: Seed coating (S)

S_0: Control

S_1: Gum coated seed 0.5 g

S_2: Tea leaf powder 10 g

S_3: Turmeric rhizome powder 10 g

S_4: Garlic bulb powder 10 g

S_5: Groundnut shell (biochar) 10 g

S_6: Neem leaf powder 10 g

S_7: Curry leaf powder 10 g

S_8: Lemon leaf powder 10 g

S_9: Arappu leaf powder 10 g

S_{10}: Tulsi leaf powder 10 g

S_{11}: Fenugreek seed powder 10 g

Total treatment combinations: 36

Note: Coated seeds will be stored in HDPE bags and the observations will be recorded up to the germination went below ISTA standards.

13.3 Seed coating methodology : The fresh leaves of different plants will be plucked and cleaned properly. These cleaned leaves will be shade dried for 7-10 days at room temperature. After drying, leaves will be grinded with electric grinder to make fine powder. These powders will be sieved through muslin cloth and stored in air tight

containers. 100 g of seed will be taken in flask and 2 ml of Gum will be added to seed and spread thoroughly all over the seeds by vigorous shaking and immediately add 10 g of leaf powder of botanicals will be to the flask and shaken vigorously so that all the seeds will be coated evenly.

13.4 Method of storage

The coated seeds of soybean with different botanical powders will be packed in different HDPE bags separately. The HDPE bags will be zip locked and stored under different storage conditions.

13.5 Observations to be recorded

13.5.1 Field observations (Experiment I)

Ten plants in each plot will be randomly selected and their average will be used for recording the seed yield and yield attributing characters, except for days to 50 per cent flowering, days to maturity and flowering duration. Days to 50 per cent flowering, days to maturity and flowering duration will be recorded on plot basis.

13.5.1.1 Days to 50 per cent flowering

The number of days will be recorded from the date of sowing to flowering initiation in 50 per cent plants in a plot.

13.5.1.2 Days to maturity

Number of days will be recorded from the date of sowing to 80 per cent plants in a plot attaining physiological maturity.

13.5.1.3 Flowering duration

Number of days will be calculated by taking the difference between days to 50 per cent flowering and days to stop on flowering in 50 per cent of the plants in a plot.

13.5.1.4 Plant height (cm)

The plant height will be measured in centimeter from ground level to the tip of the plants at the time of maturity.

13.5.1.5 Number of clusters per plant

The total number of pods bearing clusters per plant will be recorded at maturity

13.5.1.6 Number of pods per plant

The total number of pods per plant will be counted from each selected plant at the time of harvest. Empty pods will not be included into observation.

13.5.1.7 Number of seeds per pod

Number of seeds per pod from ten randomly selected pods of each selected plant will be collected separately and average number of seeds per pod will be recorded.

13.5.1.8 100 seed weight (g)

Thousand seeds from each treatment combinations will be counted manually and the average weight will be recorded as test weight in gram.

13.5.1.9 Seed yield per plant (g)

Seeds harvested from ten randomly selected plants will be dried, cleaned and weighed in grams on an electronic balance and averaged.

13.5.1.10 Biological yield per plant (g)

Total biomass of ten randomly selected plants along with pods (excluding roots) will be dried and weighed.

13.5.1.11 Harvest index (%)

Harvest index is the ratio of seed yield to biological yield. Harvest index will be calculated as per the following formula (Donald, 1962). The average will be worked out and reported in percentage.

$$\text{Harvest index (\%)} = \frac{\text{Seed yield per plant}}{\text{Biological yield per plant}} \times 100$$

13.5.2 Laboratory observations (Experiment II)

13.5.2.1 Germination (%)

Using the between paper approach, the laboratory germination test will be carried out in accordance with the ISTA rules (Anonymous, 1999). From each treatment combination of the lab experiment, 100 seeds will be selected at random in four repetitions and spread out evenly on standard germination paper. The seed germinator, which has a constant temperature of 25°C ± 0.5°C and 95% relative humidity, will house the germination paper. On the seventh day, the regular seedlings will be examined, and the average will be shown as a germination percentage.

13.5.2.2 Shoot length (cm)

For each treatment combination, ten healthy seedlings will be chosen at random from the standard germination test will be used to measure the shoot length. Shoot length will be measured between the collar area and the end of the main shoot in centimeters.

13.5.2.3 Root length (cm)

The root length will be measured using the same ten seedlings that were chosen for measuring the shoot length. The root length will be measured in centimeters from the tip of the primary root to the base of the hypocotyls.

13.5.2.4 Seedling length (cm)

Seedling length = Shoot length (cm) + Root length (cm)

13.5.2.5 Seedling fresh weight (mg)

The fresh weight of the seedling will be recorded and averaged in milligrams using ten randomly chosen seedlings used to measure seedling length.

13.5.2.6 Seedling dry weight (mg)

After taking the fresh weight of the seedling, same ten seedling will be dried in the shade for 12 hours, then in a hot air oven at 100 degrees Celsius for 24 hours, and then weighed and averaged in milligrams.

13.5.2.7 Seedling vigour index I

Seedling vigour index I will be determined as per procedure prescribed by Abdul-Baki and Anderson (1973).

Seedling Vigour index I = Germination (%) x seedling length (cm)

13.5.2.8 Seedling vigour index II

Seedling vigour index II will be determined by as per procedure prescribed by Abdul Baki and Anderson (1973).

Seedling Vigour indexII = Germination (%) x Seedling dry matter (mg)

14. Statistical Analysis

As per the statistical methods outlined by Cochran and Cox (1957), the data gathered during field study will be analyzed statistically using a Randomized Block Design (Factorial), and the data from laboratory experiments will be analyzed statistically using a Completely Randomized Design (Factorial).

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